BSC

Study Cover Sheet

QA: N/A

YUCCA MOUNTAIN PROJECT

STRATEGIES FOR RECOVERY AFTER AN OFF-NORMAL EVENT TO THE WASTE PACKAGE TRANSPORT AND EMPLACEMENT VEHICLE

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ACRONYMS

BSC	Bechtel SAIC Company, LLC
DOE	Department of Energy
HEMF	heavy equipment maintenance facility
MT	metric ton
MRV	multipurpose recovery vehicle
TAD	transportation, aging, and disposal
TEV	transport and emplacement vehicle

1. INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

The purpose of this study is to identify potential off-normal events; and examine conceptual procedures, methods, and processes for recovery from each off-normal event.

1.2 SCOPE

The scope of this study is to evaluate potential off-normal events pertaining to the emplacement and retrieval system, specifically the transport and emplacement vehicle (TEV). There are various events that could affect TEV emplacement and retrieval operations. To limit the scope of this study to major events the following criteria will be used to validate potential off-normal events:

- Cessation of repository operations, for extended periods
- Radiological release leading to exposure of individuals to radiation.

Although unlikely, there are many possible events that would meet the above criteria. Only two events are considered in this study. The reason only two extreme events are considered is that any lesser events could be managed using a similar approach. However, the causes of these potential off-normal events are not discussed. Since this document is specific to recovery of the TEV after an off-normal event, failures and appropriate recovery methods relating to TEV structures, systems, or components will be discussed in future documents.

2. RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

No off-normal events have been identified where the TEV could not be recovered. Other potential situations that may occur could be resolved using the solutions, or any combination of the solutions described here. The strategy in recovering the TEV is to:

1. Secure
2. Notify
3. Develop
4. Obtain
5. Complete
6. Document

Using the strategy discussed above this document shows that there are reasonable and achievable recovery solutions for the foreseeable off-normal events.

3. DESCRIPTION OF ALTERNATIVES CONSIDERED

Throughout the course of emplacement operations, various off-normal events could occur and cause the emplacement operations to cease, requiring recovery of the TEV. Within this document, there have been two off-normal conditions identified as having major impact to the repository operations:

- Derailment
- Rockfall.

It is anticipated that any other off-normal events not discussed within this document could be resolved using the strategies, or a combination of the strategies, discussed within the text of this document.

3.1 STRATEGY

The potential events or issues that could possibly occur during waste retrieval operations are addressed in the following subsections, are not by any means a complete list of potential scenarios. However, for all recovery activities a team would be assembled to determine the best approach for recovering the TEV by using the strategy outlined below. The strategy for recovery from off-normal events would most likely consist of the following activities:

1. Securing the immediate area and assessing the immediate status of an involved waste package and TEV for personnel safety.
2. Notification and reporting to the Nuclear Regulatory Commission and other appropriate jurisdictions based on the significance of the event.
3. Developing a detailed recovery plan which will include:
    - Assessing nuclear and non-nuclear safety
    - Assessing security impacts during recovery
    - Assessing impacts of recovery on the environment at or near the site
    - Establishing access control and isolating the area from continued operations, if required
    - Confining contamination, if present
    - Collecting critical technical data
    - Formulating a mitigation plan
    - Designing and providing any additional specialized equipment needed for mitigation.
4. Obtaining approval for the recovery plan and recovery operational procedures.
5. Completing all actions in accordance with the recovery plan and procedures, then returning the repository to normal operation.
6. Documenting what happened and how it was resolved in a lessons learned

3.2 EQUIPMENT

Each off-normal event that occurs will need a recovery plan and a procedure of the recovery operations as described in Section 3.1. This document identifies several potential recovery plans that use a remotely operated, multipurpose, recovery vehicle. One concept, used throughout this document can be seen in Figure 3.2-1.

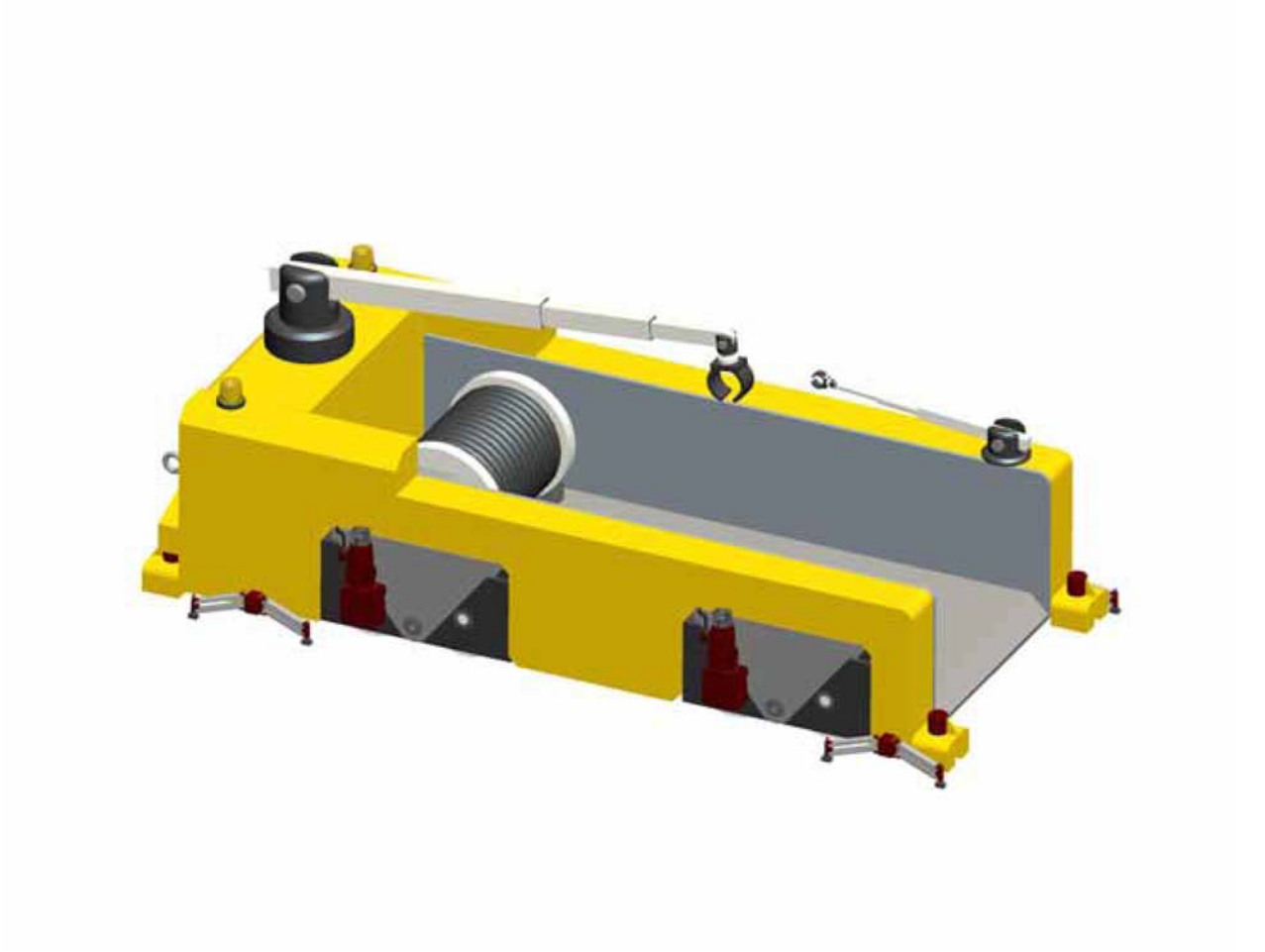

Figure 3.2-1: Conceptual Multipurpose Recovery Vehicle

The multipurpose recovery vehicle (MRV) design is based on the TEV concept. The MRV will be remotely operated, and rail based.

The MRV is similar to the TEV except that the shielding enclosure has been removed, and a fixed base plate is attached between the two chassis side members. The base plate is used to carry needed tools, equipment, and shielding to the incident location; and if needed it could carry debris away from the incident location.

Unique features that may be present are shown in Figure 3.2-1. The recovery planning team would have the option to use any or all features, as they deem necessary. Potential features include:

- Cameras and lights
- Communications equipment
- Telescoping boom crane
- Manipulator arms
- Winch
- Rail clamps

Descriptions of these features are located in the recovery plans found later in the document.

Power and communication may not be available depending on the incident. Power could be easily supplied by battery, cable tether, or any other means envisioned by the recovery planning team. Wireless radio, or a remote tether, as needed, could provide communication.

3.3 DERAILMENT

Derailment could potentially occur anywhere the TEV travels on the surface or subsurface. Recovery of the TEV after a derailment will be explored in three locations:

- Derailment on the surface
- Derailment in the North Portal, North Ramp, or Access Main
- Derailment in the Emplacement Drift

3.3.1 Derailment on the Surface

There is potential for the TEV to derail whilst traveling on the surface. A worst-case scenario would be that the TEV is carrying a waste package for emplacement.

Recovery for this scenario could be limited hands on activity, as the TEV design features will keep the waste package fully shielded. The installation of temporary shielding, similar to lead blocks or blankets, could reduce the radiation levels to workers.

The derailment feet located on the TEV should allow the TEV to be dragged easily. The simplest solution would be to install rerailers, shown in Figure 3.3-1 near the derailed TEV. Attach a cable to the TEV then using an appropriate winch system, drag the TEV over the rerailer, which would put the TEV back on the rails. This solution is preferred as it reduces hands on operations.

An alternate solution, depending on the situation, would be to use jacks to lift the TEV. Workers could then place heavy equipment rollers under the TEV and move it back over the rails. The lifting devices could then lower the wheels back onto the rail.

Any motion limiting damage to the TEV such as damage to the wheels would need to be repaired, before recovery could continue. The TEV would then take the waste package, back to a safe location, such as one of the surface nuclear facilities. The TEV would then be taken to the HEMF for full inspection, and repairs as needed.

3.3.2 Derailment in the North Portal, North Ramp, or Access Main

There is potential for the TEV to derail whilst traveling in the Access Main. A worst-case scenario would be that the TEV is carrying a waste package for emplacement.

Recovery for this scenario is more complicated than a surface recovery due to the confines of the tunnel where the TEV is located. The installation of temporary shielding, similar to lead blocks or blankets, could reduce the radiation levels to workers.

The derailment feet located on the TEV should allow the TEV to be dragged easily. The simplest solution would be to use the MRV to install rerailers, shown in Figure 3.3-1 near the derailed TEV. The MRV would attach a cable to the TEV, actuate the rail clamps, then using the on-board winch drag the TEV over the rerailer, which would put the TEV back on the rails. This solution is preferred as it reduces hands on operations.

Figure 3.3-1: Rerailer

Depending on the situation, remote jacks would be used to lift the TEV. Workers could then place heavy equipment rollers under the TEV and move it back over the rails. The lifting devices could then lower the wheels back onto the rail. This solution requires extensive hands on operations and would be a last resort solution.

Any motion limiting damage to the TEV such as damage to the wheels would need to be repaired, before recovery could continue. The TEV would then take the waste package, back to a safe location, such as one of the surface nuclear facilities. The TEV would then be taken to the HEMF for full inspection, and repairs as needed.

3.3.3 Derailment in the Emplacement Drift

3.3.3.1 Scenario Description

This section will address the recovery of a derailed TEV in an emplacement drift. The worst possible location a derailment could occur is when the TEV is moving into final position to place the waste package. At this stage of emplacement, the shield doors are in an open position, the base plate is in an extended position and the waste package is inside the TEV shielded enclosure, as depicted in Figure 3.3-2.

The radiation from the waste packages within the emplacement drift prevents workers from accessing the TEV; therefore, recovery must be remote. The MRV, or any derivative, will be used to remotely recover the TEV.

3.3.3.2 Simple Solution

The TEV is constructed with "derailment feet," which are fabricated and mounted to the TEV frame. The "derailment feet" prevent the TEV wheels from contacting the invert structure when derailed; allowing the frame to drop a couple inches onto the top of the rail. In the event that the TEV is detached from the waste package the MRV would be able to attach to the TEV and drag it out.

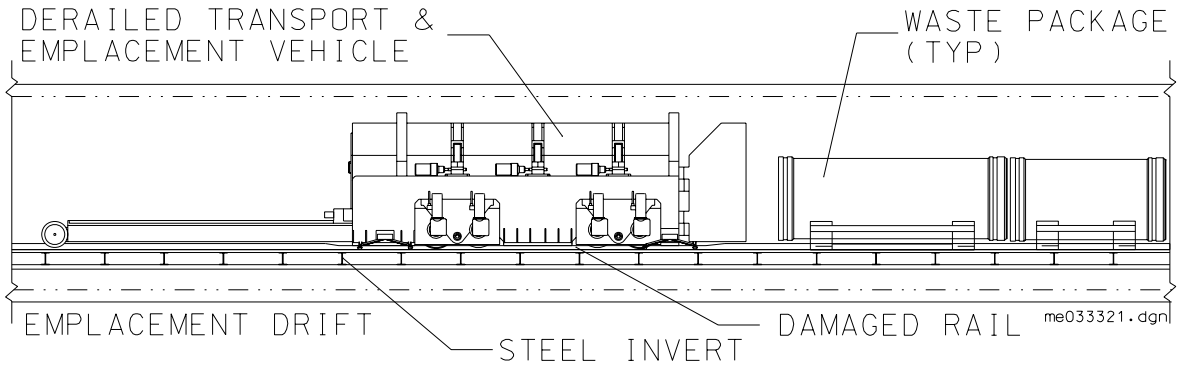

Figure 3.3-2: Derailed TEV in the Emplacement Drift

3.3.3.3 Worst Case Solution 1

A worst-case scenario would be a derailed TEV, with a waste package partially emplaced, but still inside the TEV. If possible the shield doors would be closed, and the base plate retracted. Due to the confinement of the emplacement drift it may be easier to drag the TEV and waste package into an evacuated access main. However, this recovery solution may necessitate the removal of the turnout access door and bulkhead to provide the required clearance for the derailed TEV. The derailed TEV could be rerailed using strategies discussed in Section 3.2, and the waste package could be recovered at a later time.

3.3.3.4 Worst Case Solution 2

In a scenario where the drive system for the base plate has been damaged and the base plate cannot be retracted, a more complex solution is needed. In this situation, the base plate would need to be removed. One recovery scenario begins with the MRV entering the emplacement drift and attaching a towing device to the base plate. The MRV drive system would be sufficiently sized to overcome the failed base plate drive mechanisms and drag the base plate out of engagement with the TEV and then out of the emplacement drift (Figure 3.3-3); or if needed, cutters could be used to remove the base plate. After removal of the base plate, the MRV installs rerailers (Figure 3.3-4). The rerailers may be similar to those in the railroad industry, but modified for this particular application (example rerailer depicted in Figure 3.3-1). When the rerailers are in place, the winch installed on the MRV is attached to the TEV (Figure 3.3-5). The MRV rail clamps would clamp onto the rail and the winch would pull the TEV over the rerailers, placing the TEV fully on the rails. When the TEV is back on the rail, the MRV would need to engage the TEV shielded enclosure lifting system drive, to lower the shielded enclosure. Once

the waste package is separated from the TEV; the MRV could continue to tow the TEV out of the emplacement drift, if necessary.

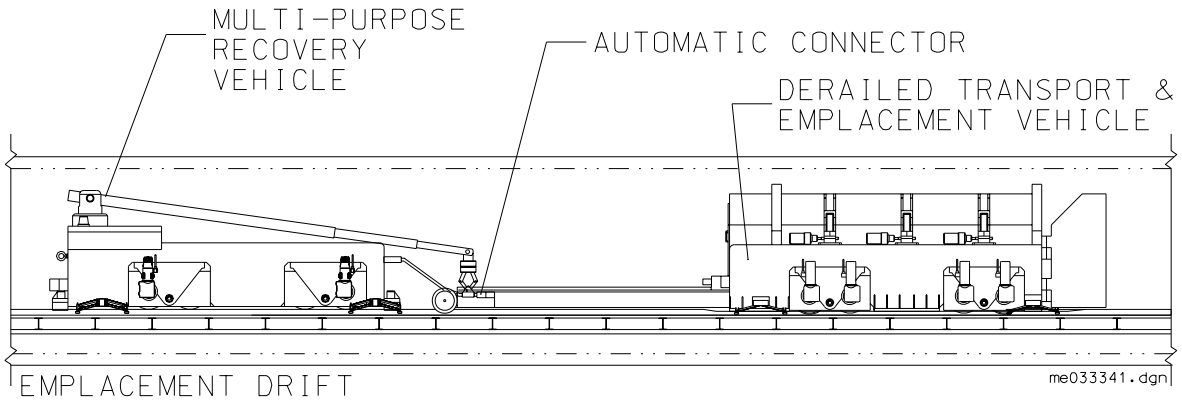

Figure 3.3-3: MRV Removing the TEV Base Plate

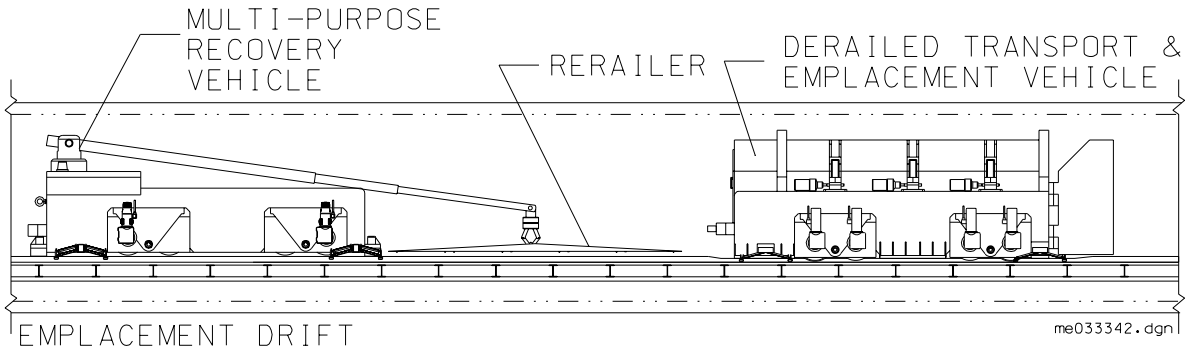

Figure 3.3-4: MRV Installing Rerailers

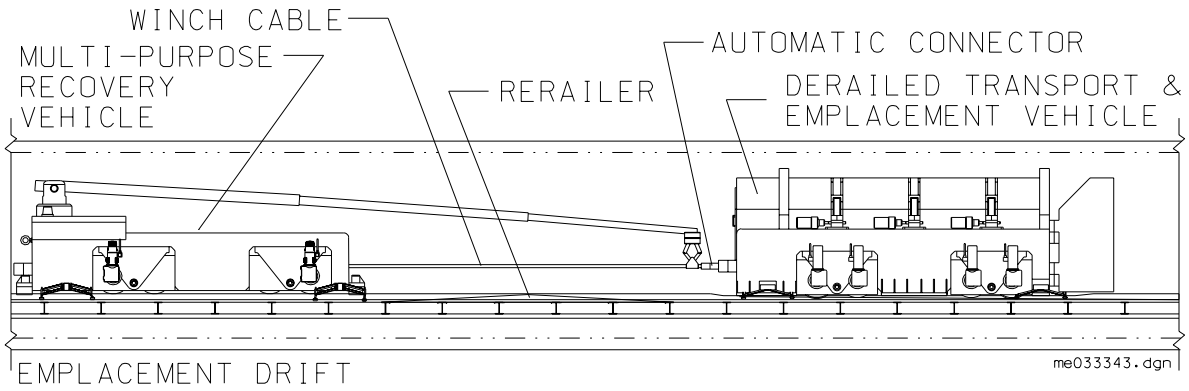

Figure 3.3-5: MRV Attaching the Winch Cable

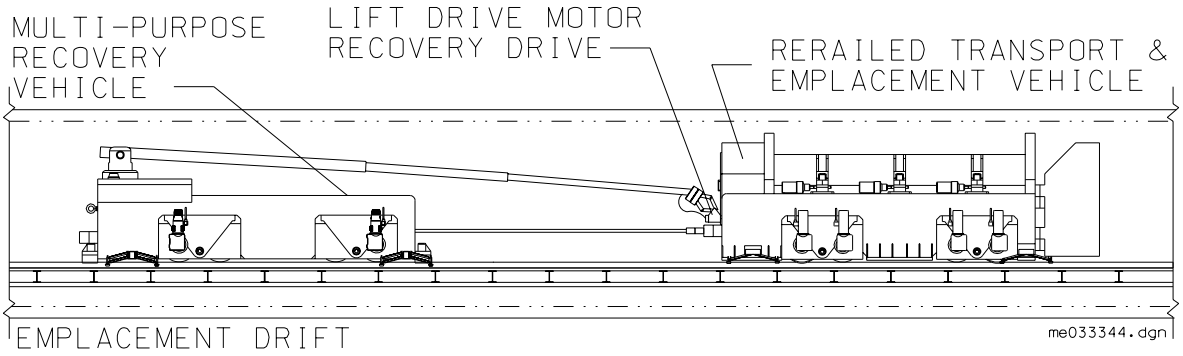

Figure 3.3-6: MRV Lowering the Shielded Enclosure

3.3.4 Damaged Rail within Emplacement Drift

If a section of the rail were to be damaged, as shown in Figure 3.3-7, the rail would need to be fixed before operations could continue. The first step would utilize a MRV that would remotely drive into the affected emplacement drift and install a temporary shield wall, shown in Figure 3.3-8. After installation of the wall and a radiation inspection, workers could enter the emplacement drift and install new rail. The MRV would be used again to remove the temporary shield wall, and emplacement operations could restart.

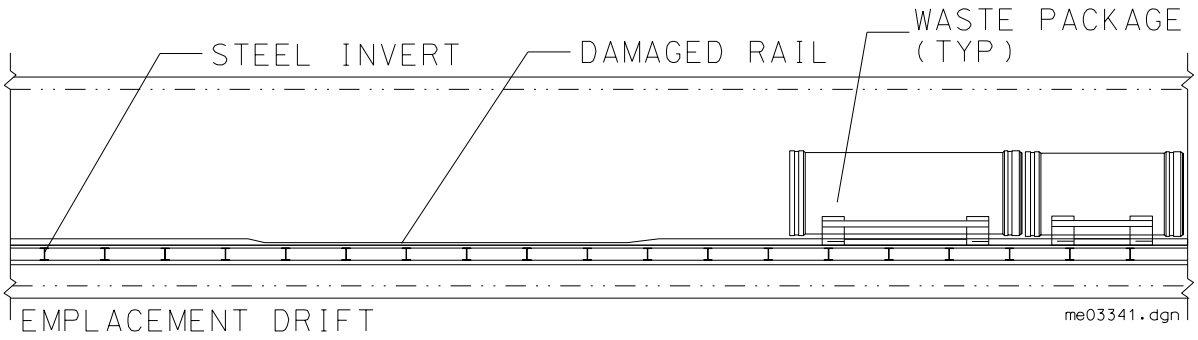

Figure 3.3-7: Damaged Rail in the Emplacement Drift

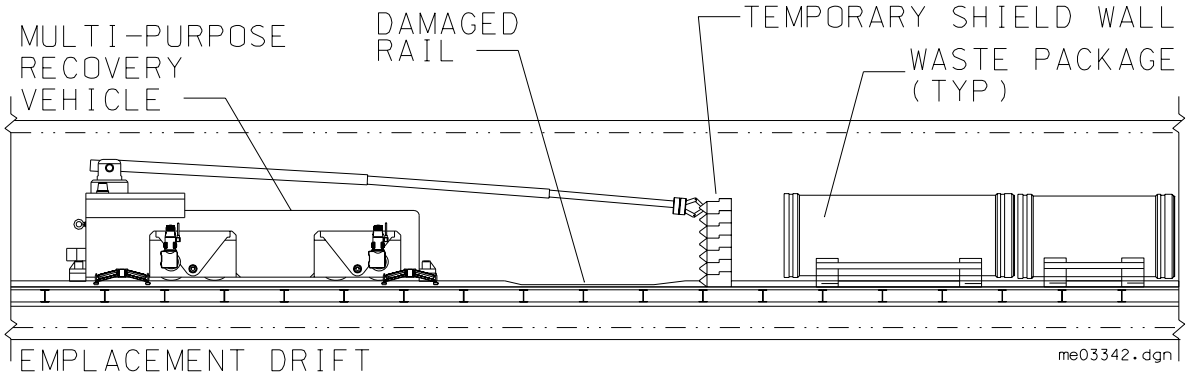

Figure 3.3-8: MRV Constructing Temporary Shield Wall

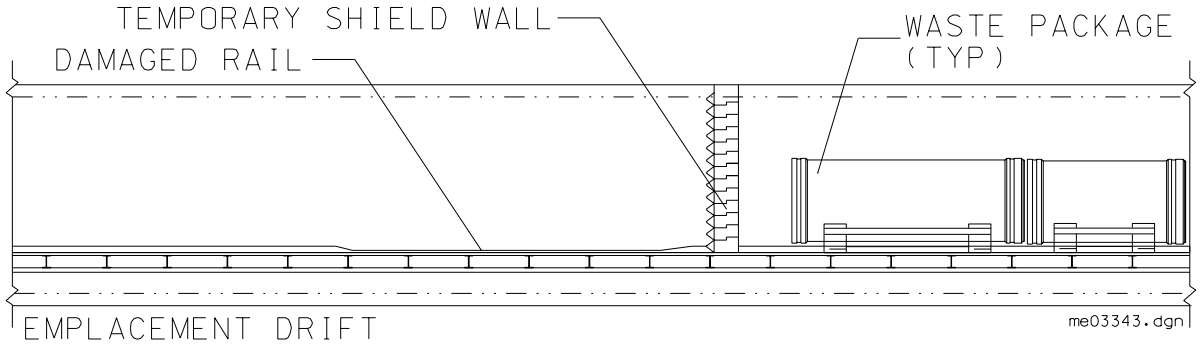

Figure 3.3-9: Fully Constructed Temporary Shield Wall in Emplacement Drift

3.4 ROCKFALL

There is a potential for rockfall anytime the TEV is in the subsurface. Rockfall in the North Portal, North Ramp, or Access Main, will not be discussed, as this is a permutation of recovery from rockfall within an emplacement drift.

Depending on how the rock falls and where the TEV is impacted, rockfall can create two possible recovery scenarios where:

- **The TEV structure remains intact**. The TEV shielded enclosure lifting mechanisms, shield door actuators, and base plate drive system are damaged. The waste package remains inside the TEV.

- **The TEV structure fails.** The shielded enclosure and base plate falls to the ground leaving the TEV unmovable. The shielding integrity of the TEV is compromised and recovery of the TEV becomes a remote activity.

3.4.1 Approach for Rockfall Removal

If a rockfall were to occur on the TEV, and the TEV structure remained intact the MRV would remove the rocks and the TEV would be recovered as in Section 3.3.

The worst possible time a rockfall could occur is when the TEV is moving into final position to place the waste package. During this time, the shield doors are in an open position, the base plate is in the extended position, and the shielded enclosure is in the raised position, as shown in Figure 3.4-1. During the rockfall, the rocks can hit several components rendering them inoperable and making the recovery effort more difficult. These components could include the shield door actuators and hinges, shielded enclosure lifting devices, drive motors, and the base plate.

The first step in recovery is to remove the collapsed emplacement debris. Debris would consist of rock pieces, ground support, and rock bolts. The MRV would need to clear the collapsed drift remotely using the telescoping boom crane. Rock debris would be picked up and removed. The ground support, and rock bolts, would need to be split into small manageable pieces using cutters, to facilitate removal.

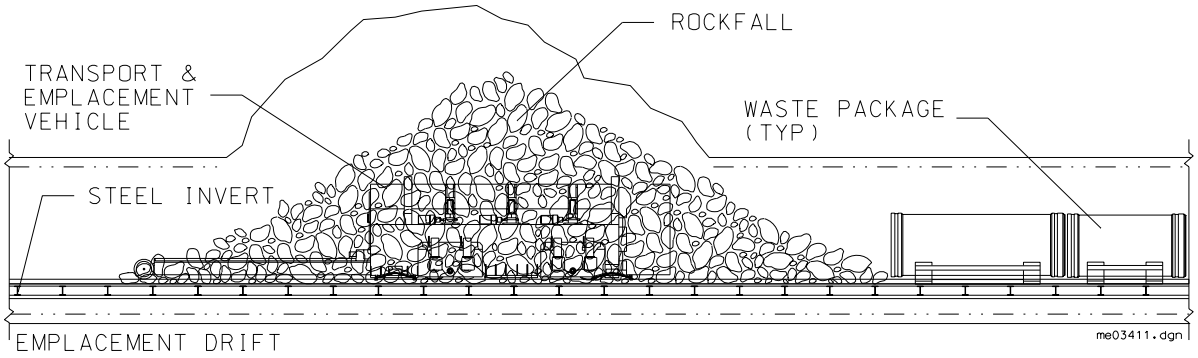

Figure 3.4-1: Rockfall on the TEV in the Emplacement Drift

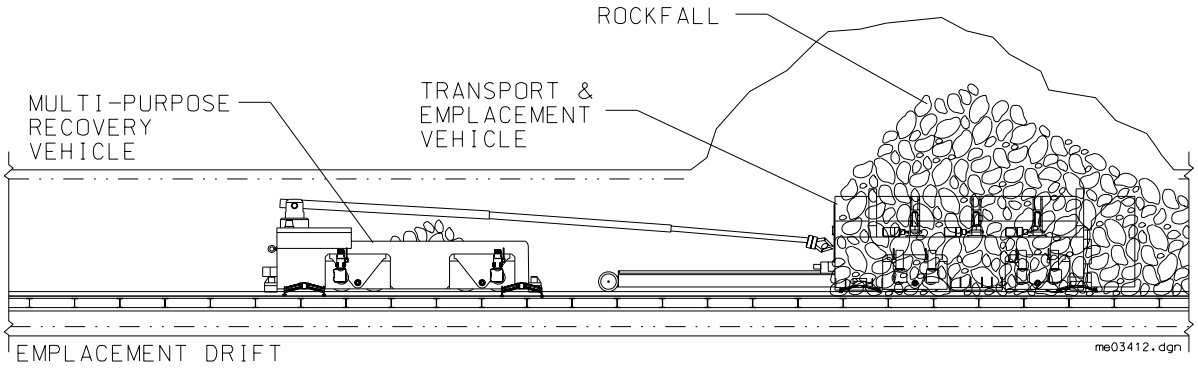

Figure 3.4-2: MRV Removing Debris around the Extended Base Plate

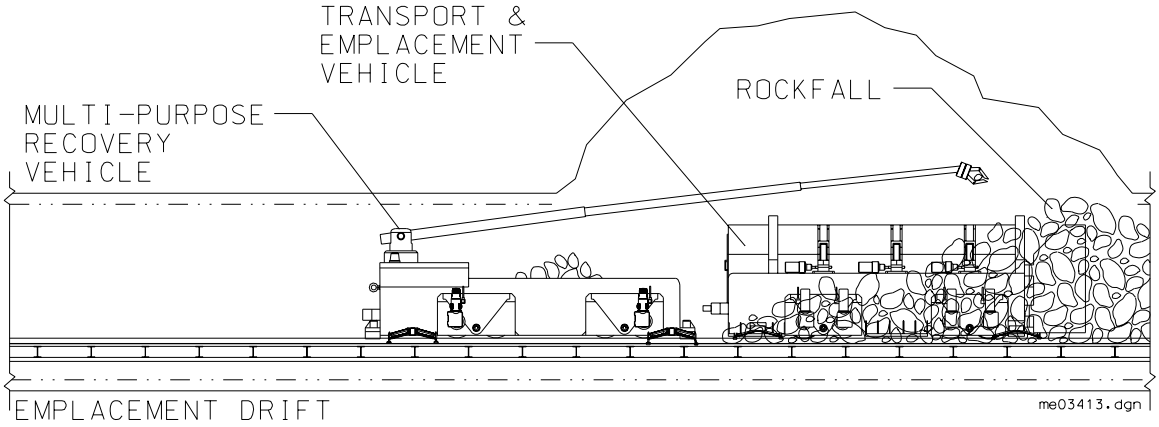

Figure 3.4-3: MRV Removing Debris around the TEV

The TEV shielded enclosure lifting devices cannot be used to lower the shielded enclosure; the lifting features are cut using the MRV with a cutting attachment fitted to the telescopic boom arm. This will allow the shielded enclosure to fall thus placing the waste package and pallet on the invert structure.

Once the debris is removed and the waste package and emplacement pallet are on the invert structure, extraction of the TEV is similar to removal of a derailed TEV (see Section 3.3).

After the waste package and pallet is removed; the damaged third rail and communications channel may be in need of repair. The MRV returns to the Emplacement Drift to remove the

remaining debris (Figure 3.4-4). When all the debris is removed, the damaged third rail and communications channel would be fixed similarly to Section 3.3.4.

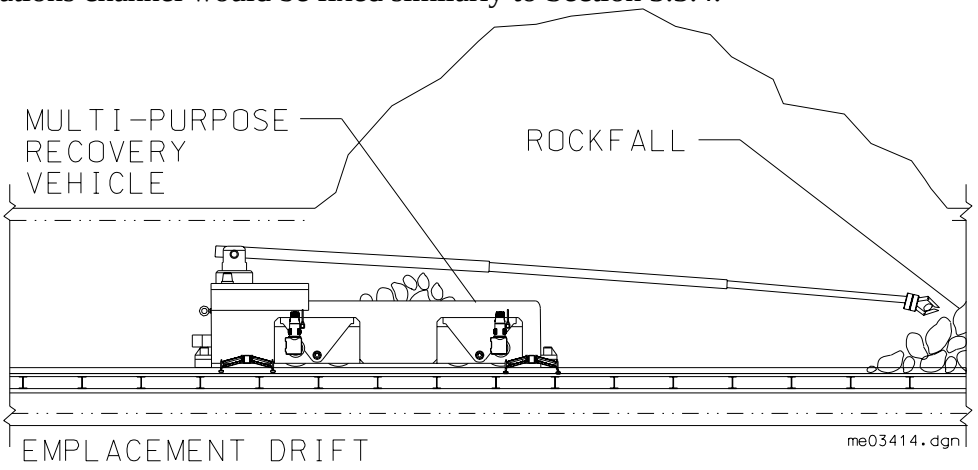

Figure 3.4-4: MRV Removing the Remaining Debris

3.4.2 TEV Structure Fails

If the rockfall were severe enough to damage the TEV structure, recovery would be very difficult. The TEV is completely inoperable. The waste package and pallet are placed on the invert, but in an unknown position. The shielded enclosure structure is heavily damaged and laying on the invert. Furthermore, the crane rails, third rail, and communication channels could be damaged and unusable.

The debris and base plate would be removed as before. Depending on the damage, the TEV structure may need to be dismantled using various cutting devices mounted to the MRV telescopic boom arm. The cut TEV components would be placed on the MRV flatbed for removal from the emplacement drift (Figure 3.4-5).

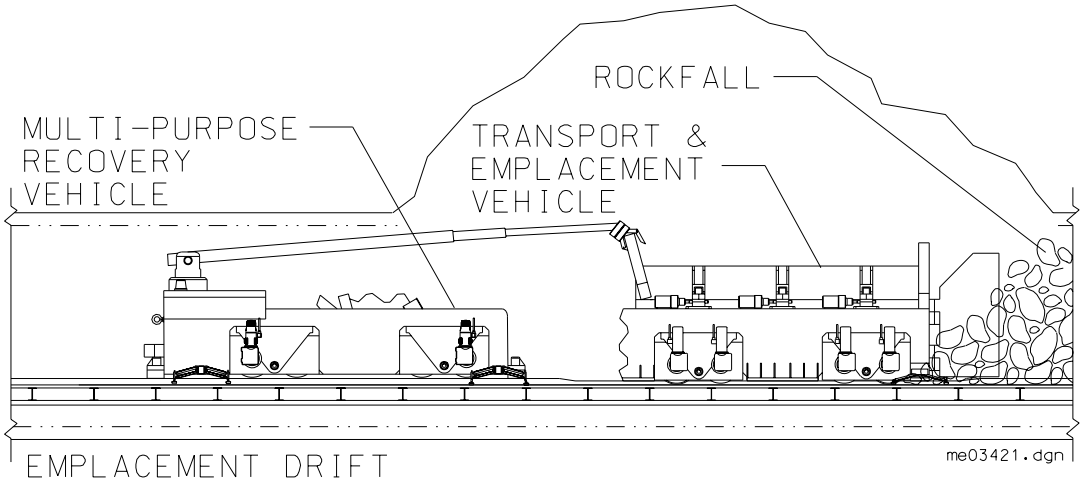

Figure 3.4-5: MRV Dismantling TEV

3.5 WASTE PACKAGE RETRIEVAL

There may be a need to remove the waste packages from the emplacement drifts. It is likely that after a severe event the waste packages may have shifted form the original locations. A waste package realignment vehicle would be needed to move the waste package and pallet to a recoverable position. This vehicle would be a derivative of the MRV, but with hydraulic or electrically powered arms fitted, that could locate a waste package pallet and slide the waste package and pallet across the invert structure into a recoverable position (see Figure 3.5-1).

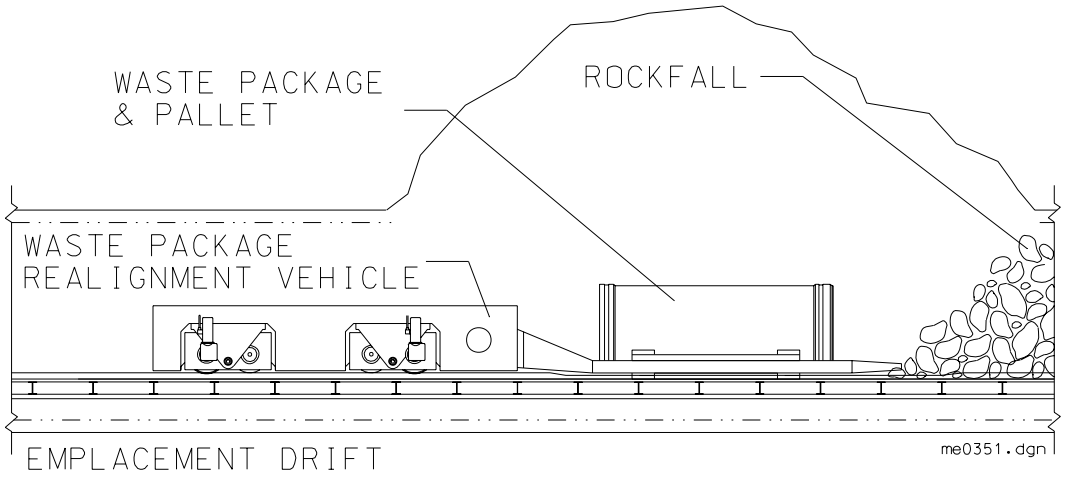

Figure 3.5-1: Waste Package Realignment Vehicle Moving the Waste Package and Pallet

Once in position, the TEV would be able to remove the waste package from the emplacement drift and move it to a surface nuclear facility for inspection and if necessary remedial action.

4. REFERENCES

4.1 DOCUMENTS CITED

None

4.2 PROJECT PROCEDURES / DIRECTIVES

None

4.3 REGULATIONS, CODES, AND STANDARDS

None